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Research On The Operation Of Bag Filters For Dust And Gas Cleaning In Cement Production (On The Example Of Factories In The Ferghana Region Of The Republic Of Uzbekistan)

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ABSTRACT

Cement production is one of the most common man-made air pollutants. In this regard, the need for dust collection in this process is obvious. The article presents an analysis of the used designs of dust collection devices in the cement production of the Fergana region of the Republic of Uzbekistan. Methods of tissue filter regeneration are analyzed. The results of experimental studies on the state of synthetic fabric bag filters installed on air purifiers from dust and gas flows are presented. The choice of the standard size, design and the required number of fabric bag filters was made. For technical and economic reasons, there is a method and mode of filter regeneration that does not cause severe wear of the fabric, due to which the duration of filter operation without expensive stops for current repairs is significantly increased.

KEYWORDS

Cement production, dust collectors, bag filters, regeneration, dust and gas flows, dust cleaning, air purifiers, synthetic filter fabrics, ecology.

INTRODUCTION

According to official data [1] currently, 22 cement plants in the Republic of Uzbekistan produce about 11 million tons of cement per year.

The development of the construction industry over the past 5 years has dramatically increased the demand for cement in both domestic and foreign markets. In this regard, the Government has set a goal to increase the volume of cement production to more than 20 million tons per year by 2025. This is planned to be achieved not by increasing the capacity of existing enterprises, but by building and commissioning new plants. So, in the Fergana region there are 6 plants with a capacity of 0.5 million tons per year each, which is 1400 tons per day, 4 plants of the same capacity are being built and are at the stage of commissioning. At the same time, the cleanliness of the surrounding air pool is provided by them by 95 %. There is a share of emissions, existing dust collectors need to be systematically improved and require energy and resource-saving developments.

MATERIALS AND METHODS

We are conducting research to improve the standard sizes, weaving material design, design and optimal number of synthetic fabric bag filters themselves. Below is a detailed description of their work.

After a certain period (from several tens to several hundred hours, depending on the operating conditions) of filter operation with alternating filtration and regeneration cycles, the residual amount of dust in the fabric is stabilized and corresponds to the so - called equilibrium dust content of the fabric and the residual resistance of the equilibrium dusty fabric. The values of these values depend on the type of filter material, the size and properties of dust particles, the relative humidity of gases, the method of regeneration, and other factors.

Sometimes the residual resistance of the fabric continuously increases, that is, there is clogging or "smearing" of the fabric. This phenomenon is not directly related to the air permeability of a clean fabric, but occurs primarily as a result of particles getting stuck inside the fibrous yarn and in the pores between the threads due to a high pressure drop, as a result of chemical and physical processes occurring in the dust located in the pores and on the yarn fibers, especially in the presence of moisture or electrostatic interactions.

To assess the feasibility of using fabric filters in each of the specific cases, data from the operation of filters with suitable fabrics in conditions similar to those under consideration are used, specifying the optimal performance parameters by testing pilot plants.

Some features of the device and classification of the studied fabric filters are distinguished by the following features:

- The shape of the filter elements–bag;
- The presence of supporting devices in them–frame;
- At the location of the fan relative to the filter-suction;
- According to the method of tissue regeneration-pulse;
- By the presence and shape of the housing for placing filters-rectangular;
- By the number of sections in the installation–multi-section;
- By the type of fabric used-synthetic.

The size of the sleeves is determined by design features and economic considerations. the higher the height of the sleeves, the larger their diameter is usually (this is done in order to reduce the wear of the fabric at the entrance to the sleeve). Table 1 shows the technical characteristics of the FR type filter units used at the Ferganacement LLC plant [2].

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Table 1. Technical characteristics of FR type filters on LLC " Ferencement"

Installations	ФР-1	ФР-2	ФР-3
Number of modules, PCs	1	1	1
Filter surface area, m2	4550	2060	1310
Overall dimensions, m	8x15x13	7x13x9	6x10x10
Weight, t	71,5	37,5	27,5
Number of sections in the module	20	22	14
Number of cells in the section	65	78	78
Length, L mm	7000	3000	3000
Diameter, d mm	165	135	135
Ratio of sleeve length to diameter	42-1	22-1	22-1
Filter material	Polypropylene synthetic fabric		

The number of filters in a complete installation: (20x65)+(22x78)+(14x78)=4108 pieces, the total area of the required fabric is 7920 m2.

One of the significant disadvantages of this type of cleaner is that dusty gases are introduced into the hoses from below. When entering from below, the possible length of the sleeves is limited, as it is difficult to ensure that dust falls out during a short period of shaking. In addition, due to fractional screening, very fine dust accumulates in the upper part of the sleeves, which is poorly discharged during regeneration. When entering from above, the direction of gas flow contributes to the dust fallout in the hopper and longer hoses can be used, but in this case there is a risk of a significant increase in temperature in the upper part of the filter housing, and the devices for tensioning the hoses are more complex. This justifies the above drawback.

Stiffening rings are installed in the sleeves to prevent their compression and facilitate the fallout of dust into the hopper during regeneration at certain distances. The sleeves are put on the pipes and sealed with clamps with screw clips. The pipes are provided with annular collars that prevent the sleeves from slipping off. Since this is where the fabric undergoes the most wear, this part of the sleeves is doubly reinforced and impregnated with latex.

Fastening of sleeves in sockets by the lower cast-iron tube of a lattice without branch pipes is carried out by thin spring rings from special steel which after additional covering with fabric are sewn into sleeves. To avoid flattening, the sleeves are put on wire frames.

The housings are made of sheet steel, and must be sealed to prevent cold air from being sucked in, which can cause condensation of water vapor, they are made hermetically.

The suction filter housings are designed for a vacuum of 3 kPa. Under special conditions, the design vacuum for housings increases to 10 kPa.

If necessary, the housing is covered with thermal insulation or heated.

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For inspection of hoses when servicing filters in sections, passages are arranged not only on the pipe grate, but also at the level of the suspension of the hoses. Each sleeve is accessible from the aisles, and the distance between the sleeves (at least 50 mm) ensures reliable fastening and does not allow mutual friction. Service of hoses is carried out through hatches.

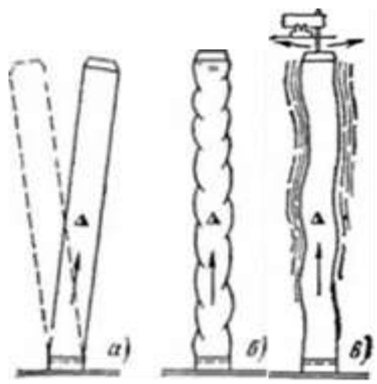

Figure 1. Ways to shake the sleeve.
a-shaking in the horizontal direction; b - loosening and tension of the sleeve in the vertical direction; C-vibration

The disadvantages of the described filters include the complexity of changing bags and abrasion of the fabric on the frame.

It is known that there are two main ways to regenerate dusty tissues: - shaking the filter elements (mechanical, aerodynamic by pulsation or sudden changes in the direction of the filtered gas flow, sound vibrations, etc);

- reverse purging of filter elements with purified gases and air (injection of low-pressure gases into the section at a high flow rate, suction of atmospheric air, local jet purging of each sleeve or flat element, etc.);

Many filters combine both methods of regeneration. Mechanical shaking of the sleeves fixed on a common frame closed from above is most effective in the longitudinal direction, but the sleeves are very worn out, especially in the lower part. The shaking should be short and sharp, but not so strong as to cause large mechanical forces in the fabric. Oscillatory movements of the upper parts of the sleeves in the horizontal direction cause much less wear, but they are less effective, since the vibrations do not propagate well along the length of the sleeves (Fig. 1).

Dust is removed unevenly along the length of the sleeve. Usually, more dust remains in the middle part of the hoses, which causes an uneven distribution of gas velocities and faster wear of those places where the regeneration process is more intense - in the upper and lower parts, depending on the method of shaking.

The minimum filtering surface of fabrics and the maximum service life of hoses are achieved by combining short filtration and regeneration cycles. However, if the efficiency of gas cleaning immediately after shaking is very low and the sediment is formed slowly, then a high initial speed is necessary to ensure the rapid formation of such a sediment. And then a long period of effective gas purification until the set value ρ p is reached. This method is often used when operating high-temperature synthetic filters that operate at low speeds and long filtration cycles [3].

кPa/(m/min)

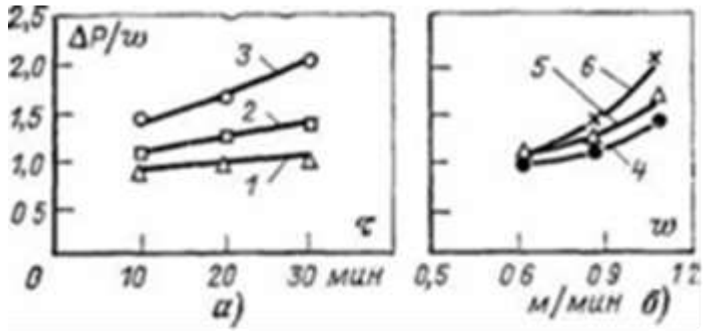

Fig.1 Dependence of specific resistance of the fabric in the bag filter:
a - the duration of the filtration cycle at different speeds (m/min) 1 - 0 63, 2- 0, 87, 3 -108;
b -the rate of filtration during different duration of the filtration cycle (min.) 4 - 10, 5 - 20, 6- 30

The power consumption per fan, which is proportional to the aerodynamic drag of the filter, increases linearly with increasing intervals between regenerations, but the duration of the filtration cycle at this speed does not significantly affect the energy consumption, especially in conditions of low gas loads (Fig. 1A).

At certain values of intervals, a power-law dependence of the energy consumption on the filtration rate is observed (Fig. 2b)

These experimental ratios were obtained when filtering cement dust in synthetic fabric filters [4].

The shaking mechanisms must be serviceable and their wear parts must be removed from the gas stream.

Aerodynamic shaking can be performed by applying a pulse of compressed air inside each filter element (Fig. 2). This type of regeneration is used in frame bag filters. The excess pressure of compressed air during regeneration is 0.4-0.8 MPa, the pulse duration is from 0.1 to 0.2 seconds, the required pulse frequency depends on the nature of the filter resistance change and is usually 5-10 pulses per minute for each sleeve. Increasing the pulse duration is inefficient, and the residual equilibrium resistance of the filter is inversely proportional to the square of the compressed air pressure in the receiver, the pulse frequency to the power of 0.5, and directly proportional to the input concentration to the power of 0, 25 [5].

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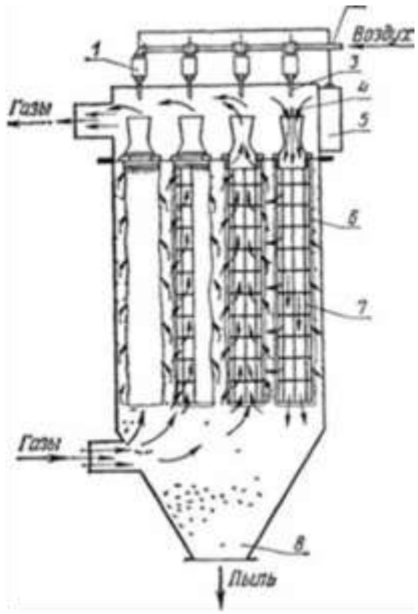

Fig 2 Frame bag filter with pulse blowing

1-solenoid valve 2-compressed air inlet pipe 3-nozzle 4-compressed air jets 5-automatic regeneration control device 6-sleeve 7-frame 8-hopper

For technical and economic reasons, the aerodynamic drag of the filters should not exceed 0.75-1.5 kPa and only in special cases can be 2-2. 5 kPa. At a higher resistance value, the slip increases sharply and it is possible to break the sleeves or destroy them along the seam as a result of aerodynamic impacts when switching sections to regeneration.

The efficiency of dust cleaning in fabric filters is quite high, but may be reduced due to fabric defects, poor pressure on the pipes or sockets, wear or exhaust hoses. According to numerous tests, the residual dust concentration after fabric filters is 5-50 mg / m3.

The main factor that determines the required area of the filter cloth in the device is the pressure drop on the fabric, not the efficiency of gas purification, and only in some cases the permissible gas load on the fabric is determined by the expected value of the residual dust concentration.

For the approximate calculation of square filter fabric filter regeneration strategy should determine the total flow of dusty gas entering the fabric (subject to the suction of air in the gas circuit from the source of dust emission to a filter cloth), and the flow rate of the purge gas or air coming from the regenerated section. In addition, it is necessary to know the permissible gas load (filtration rate), which is taken on the basis of operating experience, depending on the fabric used, the method of regeneration and the properties of dust [6].

The total filtration area of the installation, m2 will be:

(1)

where Sp—the area of filtration in the concurrent sections, m2; Sc - the area of tissue in the regenerated section, m2; Q1-flow of dust-Laden gases given suction, m3/min, Q2 - flow rate of the purge gas or air, m3/min w - speed.

filtration (gas load on the fabric), m3/(m2 * min).

After determining the total area of the fabric, find the required number of filters or sections n in a multi-section installation:

(2)

there S1 is the area of filter hoses in one filter (in one section), m2.

Since n must be an integer, the resulting value is rounded up to increase the number of filters or sections.

It is practically established that in many cases, the gas load and wear of the hoses primarily depend on the input concentration and size of dust particles, and often a large dust content and high dispersion cause the need to increase the size of the filter. Therefore, the calculation of the required fabric surface was based not on the accepted gas load, but on the amount of dust entering per unit of the fabric surface [7].

The total resistance of an installation with bag filters is the sum of the permissible resistance of the fabric, the calculated resistance of the flues and the filter housing.

The flow rate of purge air in filters with shaking for regeneration by reverse purge is 1.5-1.8 m3/(m2-min), the ratio of purge air flow to filtration flow is from 1.5 to 2.for synthetic fabrics, this ratio is assumed to be lower, in order to avoid too intensive cleaning.

It was mentioned above that the value of the pressure drop on the filter is largely determined by the method of tissue regeneration. If the adopted method and regeneration mode are not very effective, then to successfully remove dust from the fabric, it is necessary either to accumulate thick layers of dust with a corresponding decrease in the filtration rate, which leads to an increase in the size of the filter, or to intensify the regeneration mode. But at the same time, the service life of fabrics is reduced, since they are subjected to more frequent strong mechanical influences. The capital cost of such filters is usually lower, but the subsequent maintenance and replacement costs of hoses and wear parts are high.

When using filters in which the method and mode of regeneration do not cause severe wear of tissues, but are associated with a significant increase in their area, the initial costs increase, but the duration of operation of filters without expensive stops for routine repairs increases significantly. In this case, large capital expenditures are compensated for by longer operation of hoses and moving parts and lower maintenance costs. Often, fabrics in such installations can withstand 1 million tons. regeneration cycles, which is very rarely achieved in filters with reverse purging and simultaneous vertical shaking of the hoses. It should be noted that the cost of replacing one set of hoses is 10-20% and higher than the total operating costs.

In table 2 shows the approximate filtration rates of cement dust in fabric filters used in the cement industry [8], and the given value refers to the average values of input dust concentrations, which are also characterized by the size and shape of particles, and other properties specific to the captured material and the technological process. Filtration rates will generally be lower at higher concentrations and temperatures and at smaller particle sizes than is commonly found.

Table-2. Recommended filtration rates in bag filters, m/min

Dast class	Type of dust	Filter		
		with shaking and blowing	with pulse purge	with reverse purge
1	Cement from furnaces	0,45 – 0,6	0,8 – 2,0	0,33 – 0,45

One of the main conditions for the normal operation of fabric filters is to maintain the required temperature of the cleaned gases at the inlet to the filter and inside it. At temperatures higher than indicated in table 2, the service life of fabrics is sharply reduced, and at temperatures below the dew point, water vapor condensation is possible, accompanied by the formation of non-removable growths or almost complete loss of gas permeability of the fabric and increased corrosion of metal parts.

The gas temperature at the filter outlet should be 15-30 °C above the dew point temperature. When the filter is operating under vacuum, measures must be taken to minimize the suction of atmospheric air in the housing. If necessary, the housing is covered with thermal insulation. Filters should be installed in warm areas of the room. If an additional amount of heat needs to be applied to the filter and this cannot be done by increasing the temperature of the gases in the process unit, then the dusty gas is additionally supplied with air heated by electric heaters, steam heat exchangers or by directly burning natural gas in this air. Installation of electric or steam heaters inside the enclosure is impractical due to the risk of steam leakage and dust on the heater surfaces.

Often, the tissue is re-purged with heated air to regenerate it. The bins also have to be heated to prevent dust from sticking to the walls, which is especially important when the filter stops, when the dust is completely released from the bins.

Dusty gases sometimes need to be cooled to a temperature acceptable for fabric use. Gas cooling methods are considered separately.

When cleaning gases with an increase in temperature, the volume of gases to be cleaned increases. Therefore, regardless of the heat resistance of the fabric, you should always compare the additional capital costs of the cooling system and the cost of cleaning basins with elevated temperatures.

An important role in ensuring a stable process of cleaning the fabric from trapped dust is played not only by the method used and the regeneration mode, but also by the ability of the fabric to regenerate. The latter depends on the nature of the surface, the flexibility of the fabric and special surface treatment.

The main reasons for clogging fabrics are increased hygroscopicity of dust, high humidity of gases and the presence of dust in some emissions with excessive electrical charging.

To eliminate the influence of electric charging of particles, measures are taken to ensure their rapid discharge, while using electrically conductive fabrics, and increasing the relative humidity of gases to 60-70% [9]. However, it should be borne in mind that when the relative

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humidity of gases is increased (above 70%), the service life of a number of synthetic fabrics (Dacron) is sharply reduced.

The dimensional stability of filter fabrics over the entire service life is also an important factor for ensuring reliable operation of filters and extending the service life of hoses. When possible, choose the most stable, correctly thermally fixed fibers and fabrics to prevent shrinkage or stretching of the sleeves at elevated temperatures.

CONCLUSION

The tension of the hoses must be monitored throughout their service life. Inside the case, it is necessary to provide conditions for performing sleeve tightening.

The service life of fabrics varies depending on the conditions of use, the design of the device and the quality of its service. The average service life of the hoses is from 9 months to 2 years, although it can vary from a few weeks to 10 years. The quality of installation and maintenance of the sleeves and regeneration mechanisms has a great influence on these terms.

The economic effect is expected to be achieved from the ongoing research aimed at energy and resource conservation, the calculation of which will be published later.

REFERENCES

1. «O‘zsanoatqurilishmateriallari» uyushmasi. (n.d.). O‘zsanoatqurilishmateriallari. Retrieved November 27, 2020, from https://www.uzsm.uz/uz/
2. Abdullaev I.N., Umirzakov Z.A. (2020). Development and research of an effective dust collector for cleaning gas streams from fine dust from cement production. "International Journal of Economic Growth and Enviromental Issues" Volume:8, Issue:3, 59-62 p.
3. Abdullaev I.N., Umirzakov Z.A. (2020). Optimization of the design of dust collectors for cement production. Conference materials: "Innovative technologies in construction". Issue No. 15. TIIJT. Tashkent, 169.
4. Abdullaev I.N., Umirzakov Z.A. (2020). Analysis of existing types of dust collectors for industrial enterprises. Materials of the Republican 19-interdisciplinary distance online conference on the topic "Scientific and practical research in Uzbekistan" Part No. 16, Tashkent, pp.18-20.
5. Aliev, G.M. (1986). Dust collection and cleaning technology for industrial gases. Ripol Classic. 544.
6. Berger G., Listner W. (1994). Dust and gas cleaning plants. Heat power engineering. -. -No. 11. pp.86-90.
7. Hoffman D. (1995). Improving dust collection in cyclones. Chemical industry. No. 10. pp. 89-93.
8. Burenin V.V. (2008). Protection of the air basin from pollution. Labor safety in Industry. p.9.
9. Pishcheiko, S.A. (2009). Gas purification in fabric and electric filters. Eco. right., (9), 55.